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Thesis

THE EFFECTS OF THE ATOMIC BOMB AND BIOLOGICAL WARFARE ON THE ATTITUDES OF COLLEGE SCIENCE STUDENTS

by

Irving Galis

(S.B., Northeastern University,1947)

submitted in partial fulfilment of the
requirements for the degree of

Master of Arts

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

The interdependence of science and society has perhaps never been more clearly indicated than in the present atomic age. It is the attitudes and sense of social responsibility of students who are preparing to enter science that will largely determine the patterns and direction of growth of this country as it progresses through the atomic age.

I. THE PROBLEM

Statement of the problem. It was the purpose of this study to determine the extent to which the atomic bomb and biological warfare influence the attitudes of advanced college science students (at the junior, senior, and graduate levels in the fields of chemistry, biology, and physics). The attitudes which the study planned to uncover were a positive attitude on the one hand that our present civilization will continue despite the atomic bomb and biological warfare, and a negative attitude on the other hand that these destructive scientific achievements will destroy our civilization. Their attitudes reflect resultant confidence or lack of confidence in their future as a result of atomic and biological weapons which are capable of shattering our civilization.

Importance of the study. The scientists who create destructive weapons have helped to produce positive or negative attitudes to varying degrees in most thinking individuals as to the continued existence of our civilization. It was therefore necessary to know the type of attitude which young scientists will bring to science as they prepare for their future and adjust to their environment; and, since many of these individuals may soon be associated directly or indirectly with further research in atomic energy and biological warfare, their attitudes are of direct concern to this nation.

In addition, the Atomic Energy Commission is stimulating and aiding the discussion of this problem in summer school workshops, one of which is planned for the summer of 1949 at Harvard University Graduate School of Education. Teachers who have actually experimented with units in atomic energy will be invited to participate. This thesis should be an aid to those groups studying attitudes which concern atomic energy and its social implications.

II. DEFINITIONS OF TERMS USED

Attitude. Allport[1] considers an attitude to be a "... mental and neural state of readiness, organized through

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[1] Gordon W. Allport, "Attitudes," A Handbook of Social Psychology (Carl W. Murchison, Editor; Worcester, Massachusetts: Clark University Press, 1935), 1195 pp.

experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related.[2] This general theme is stated more succinctly by Thurstone and Chave,[3] who utilize the term to "... denote the sum total of a man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specific topic."[4]

As used in this study, the concept 'attitude' was interpreted as meaning the inclination (in this case, written) of an individual concerning a definite topic or situation. In this case the situation was the atomic age, which has engendered certain attitudes. A positive attitude was here interpreted as an expression ofconfidence in the continuation of our civilization even with the threat of atomic and biological warfare. A negative attitude was here interpreted as an expression of disbelief in the continuation of our present civilization, with a corresponding implication of the possible or probable destruction of our civilization by atomic and biological warfare.

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[2] _Ibid_., p. 810.

[3] L. L. Thurstone, and E. J. Chave, _The Measurement of Attitude_ (Chicago: University of Chicago Press, 1937), 96 pp.

[4] _Ibid_., pp. 6-7.

Civilization. The term civilization was here interpreted as meaning our present culture, characterized by organized groups of individuals living in states striving for progress and freedom from armed conflict among themselves.

Society. The term society was here interpreted as meaning the organized groups to which all individuals belong, and to the betterment of which constructive scientific achievements are directed.

III. ORGANIZATION OF REMAINDER OF THE THESIS

This study was organized to state a problem and to present a review of literature dealing with the aspects and certain ramifications of this problem. The problem was defined as a study to determine the extent to which the atomic bomb and biological warfare influence the attitudes of advanced college science students (at the junior, senior, and graduate levels in the fields of chemistry, biology, and physics). The attitudes which the study planned to uncover were a positive attitude on the one hand that our present civilization will continue despite the atomic bomb and biological warfare, and a negative attitude on the other hand that these destructive scientific achievements will destroy our civilization. The survey of attitudes instrument is then described, along with methods used in its application. Results of the survey are interpreted,

analyzed, and followed by a summary and conclusions. A comprehensive abstract of the thesis followed by an annotated bibliography conclude this study.

CHAPTER II

REVIEW OF THE LITERATURE

Worthy studies have been made of student attitudes toward war by Jones,[1] Kostenbader,[2] Porterfield,[3] and Pradel[4]; toward social situations by Kelly[5]; toward respect for rights by Claffey[6]; and of the effect of the atomic bomb on U. S. citizens' attitudes toward international relations.[7] This latter poll most closely approximates the theme of this thesis, but a study of the impact of weapons such as the atomic bomb and biological warfare on the attitudes of those going into science has not, at this writing, been published. Therefore, literature dealing with certain social and philosophical aspects of positive and negative attitudes, ideals, and human achievement was consulted, as well as the purely

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[1] Vernon Jones, "Attitudes Toward Peace and War," *Journal of Higher Education*, 13:5-13, January, 1942.

[2] Louise M. Kostenbader, Does War Frighten Children?" *Nation's Schools*, 34:30-1, September, 1944.

[3] Austin L. Porterfield, "Opinions About War," *Sociology and Social Research*, 22: 252-64, January, 1938.

[4] Gertrude Pradel, "Attitudes and Knowledge of Children Regarding the Present World Crisis, World War II." Unpublished A. M. Thesis, Boston University Graduate School, 1944, 108 pp.

[5] E. Lowell Kelly, "Students' Attitudes Toward Typical Social Institutions," *Psychological Bulletin*, 32:748, November, 1935.

[6] Rose Claffey, "A Study in the Attitudes of 5th Grade Children Regarding Respect for Rights and Property." Unpublished Ed.M. Thesis, Boston University School of Education, 1947, 46 pp.

[7] "How U.S.Citizens React to the Bomb. "*United Nations World*, 1: 9, October, 1947.

scientific background data on the atomic bomb, guided missiles, and biological warfare. First to be considered, however, was the position of science education concerning the socio-science relationship, which is a concomitant of the atomic age.

Literature on science education's role toward social conditions. A primary function of the science instructor as he prepares students for their places in science was summed up and clearly delineated in this statement from a highly worthwhile report on science education, which suggested that:

> The causal role of science as a basic factor in many of our present social and economic problems demands that the science teacher set the goals of instruction well beyond the narrow confines of the specialized sciences ... It is becoming increasingly more important that the science teacher seek out the social implications of his materials of instruction, and deal with them in such a way that they give promise of having more carry-over value to aid the pupil as he attempts to adjust to the problems encountered in his daily living.[8]

This plainly indicated the proposed stand of science education as its contribution to the harmonious interdependence of science and society.

Literature on Atomic Energy. Campbell,[9] writing of the discoveries necessary before the atom could be channeled for scientific purposes, described the reasoning processes through which scientists were able to arrive at what he calls "(The most

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[8] Science Education in American Schools, Forty-Sixth Yearbook of the National Society for the Study of Education, Part I, 1947. p. 141.

[9] John W. Campbell, The Atomic Story (New York: Henry Holt and Company, 1947), p. 4.

intangible of the great discoveries), that energy and matter are simply two different aspects of the same thing, as much the same as a lump of ice and the steam in a boiler."[10] With the realization of this fact and the determination of the importance of uranium, scientists had the basic facts necessary to enable them to proceed with plans to bombard the atom.

"This new atomic bomb," wrote Kaempffert,[11] "is the natural evolution of discoveries which began with radioactivity and which reached a critical stage in 1939."[12] He further described the experiments of the German physicists Hahn and Strassmann in bombarding uranium with neutrons, leading to the isolation of U-235, which was the desired isotype of uranium.

The crystallization of years of vision, hope, and sweat by unnumbered scientists was the first atomic bomb which was dropped August 6, 1945 on the Japanese city of Hiroshima. The terrible, devastating power of the bomb shook the world with dramatic intensity, and its potential further use after the termination of World War II has led into the present uneasy

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[10] Loc. cit.

[11] Waldemar Kaempffert, "The Story Behind the Atomic Bomb," Science Digest, 18: 17-19, October, 1945.

[12] Ibid., p. 17.

period commonly called the atomic age. Regarding the bomb's potential, as seen in an article considering the physical effects of the atomic bomb on people, there is the statement that: "If our next enemy set one off within a few miles of you, you could be killed either by the initial blast, by the 1,000 mile-per-hour winds which result, by the scorching heat, or by radioactivity which exists at the moment of explosion."[13] The threat of atomic bombs carried by supersonic rockets is so real and undeniable, that President Truman's Air Policy Commission has reported that at any date after January 1, 1953, this country is liable to "... mass destruction ... from an onslaught by transpolar or transocean supersonic planes and missiles..."[14] Along this line, a new civilian defense unit[15] will be set up to protect against total destruction in atomic warfare and supervised by the newly-created Secretary of Defense.

Statements of this kind are repeated because they keynote the atomic age in which young scientists are planning their future. The attitudes of these people are largely derived from the type of environment, and in the larger sense the age in which they are living.

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[13] "What an Atomic War Would be Like," Science Digest, 19:9, March, 1946.

[14] United Press dispatch, PM, January 14, 1948.

[15] Associated Press dispatch, The Boston Daily Globe, February 14, 1948.

Literature on biological warfare. There are three targets, reported Chester,[16] in this type of warfare: men, livestock, and crops. He suggested that, "In the event of another war, the American wheat crop could be devastated by enemy introduction of foreign races of stem rust."[17] However, if atomic warfare could be decisive in a matter of weeks, then biological warfare with plant diseases would be much too slow to be effective.

Dr. Gerald Wendt reported that the Chemical Warfare Service now has a crystalline-toxin which is so poisonous, that if an ounce were thoroughly dispersed, it would kill everybody in the U. S. and Canada. This is the dreaded botulinus toxin, the existence of which has been affirmed by Maj. General Alden H. Waitt, chief of the C. W. S.[18]

A recent article on 'chain reaction[19] showed this to be equally as dangerous as the atomic bomb, and reported:

> A brewery in any small country could be a germ warfare arsenal in disguise. Distilleries in the United States turned their fermentation processes to growing the molds that produced penicillin and streptomycin. In the same way, harmless looking breweries and distilleries could turn secretly to mass production of deadly germs.[20]

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[16] K. Starr Chester, "Will Bacteriological Warfare Include Plant Disease?" Scientific Monthly, 63:477-80, December, 1946 .

[17] Ibid., p. 478 .

[18] Mysterious War Poison," Science Digest, 20:69, December, 1946 .

[19] "Deadly Chain Reaction," Science News Letter, 51:342, May 31, 1947.

[20] Loc. cit.

Further, a report by Rear Admiral Ellis M. Zacharias, U.S.N. (ret.) stated that "a single milliliter of the highly infectious psittacosis (parrot fever) virus could kill twenty million men. This virus can be produced cheaply in bulk by a small laboratory anywhere in the world."[21]

This consideration of the potentialities of atomic and biological warfare leads to the social aspects involved, in which pertinent statements suggesting the socio-science interdependence are considered.

Literature on social aspects. The import of the social aspects of atomic energy has been recognized in an article reporting a proposed award by the Society for the Psychological Study of Social Issues to "the individual or group contributing ... the best action-related research in the field of the social implications of atomic energy."[22] Already completed has been a study closely allied with the problem of this thesis; the methods instrument was a poll of 6,000 U. S. citizens concerning the effect of the atomic bomb on their attitudes toward international relations. Among the attitudes uncovered were that 50% of the people said they were "not worried" by the bomb,

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[21] Time, 50:28, November 17, 1947.

[22] Kenneth J. Rehage, "The Social Implications of Atomic Energy," The Elementary School Journal, 47:547, June, 1947 .

even though some of these were among the 63% who believe there is a real danger that it will be used against the United States.[23]

In a poll conducted by the Institute of Student Opinion under the sponsorship of Senior Scholastic magazine to see what high school students thought of sharing the atomic bomb, individual ballots were cast by 142, 204 high school students all over the United States. The results showed that, "Two out of every three high school students think the United States should not share the atomic bomb secret with other nations."[24] This would seem to be conclusive evidence of the trend of thought of the American high school student, but individuals of this fourteen to seventeen year age group do not generally have the mature objectivity with which to weigh evidence on both sides and so derive societally-approved attitudes. In this case, their majority opinion may be shared by many mature individuals, but the high school student's attitude will have been re-shaped and modified many times over until the young adult is ready to take his place in society and make his presence felt through votes and opinions.

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[23] "How U. S. Citizens React to the Bomb," United Nations World, 1:9, October, 1947.

[24] "Don't Share the Bomb," Senior Scholastic, 47:29, January 21, 1946.

A keenly penetrating analysis[25] of the socio-science relationship, written in 1917, has a wealth of profound observations which are currently applicable. A pertinent statement in this regard suggested that:

> Back of the material changes ... that modern invention is bringing stand the social ideals that have guided man's crude nature into the path of achievement where he now stands. Not in the stimulating of competition and war, but in the further realization of social idealism in the making actual of ideals of brotherhood, and in the aesthetic achievements of the social arts, is the path of further progress.[26]

This vein of thought was continued, and a prognostic view, remarkably accurate for the period in which it was written concluded, "Let us not doubt that the harmony of world socialization will yet be achieved. We cannot balk the forces of evolution; we can only determine whether wisdom shall bring the consummation relatively quickly, or whether it shall be reached through the reaction from further world war."[27]

Kingsley,[28] in considering studies made of the attitudes of students toward war, described the emotional conflicts of some students who had always been taught the ways and virtues

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[25] George R. Davies, Social Environment (Chicago: McClurg and Co., 1917), 149 pp.

[26] Ibid., p. 76.

[27] Ibid., p. 81.

[28] Howard L. Kingsley, The Nature and Conditions of Learning (New York: Prentice-Hall, Inc., 1946), pp. 425-448.

of peace when abruptly told that they must fight and kill. " "Others," he concluded, "not being able to escape from years of training, entered upon their duties with resentment against war, but [were] sustained by ... a faith in the possibility of an enduring peace, and confidence in their ability to manage in the future, the affairs of the nation more successfully than their elders had done it".[29] It is this confidence that each new generation seems to possess in abundance which engenders the positive attitude many of these individuals have toward their future.

A practical philosophical view was stated by Brightman,[30] who offered this summary of science and society in regard to civilization:

> The growth of mechanical science has freed man from superstition and opened his eyes to the facts of nature. It has given him vastly increased power over nature and his fellow-man. But this power is greater than he knows how to use. A thoughtful European observer, Professor George Mehlis, has remarked that civilization is dying of its own beauty. If philosophy has no more to offer civilization than can be contained in mechanical formulae, she is but a symbol of the helplessness and futility of human life. Mechanical knowledge doubtless makes possible the control of nature; but such knowledge contains no principle indicating how it ought to be used.[31]

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[29] Ibid., p. 434.

[30] Edgar S. Brightman, An Introduction to Philosophy (New York: Henry Holt and Co., 1925), 393 pp.

[31] Ibid., p. 259.

In this regard, scientist Harlow Shapley[32] of Harvard recently called for a "pattern for survival." Dr. Shapley questioned the emphasis on the "glories of life in an atomic age and ... scientific achievement unless we set up this overall pattern for survival." He suggested international scientific cooperation as " possible model for this pattern," adding: "... science is only a small part of the whole; it can only be a beginning."[33]

To conclude the general social aspects of destructive scientific achievements, the individual and his attitudes, and the social environment, a comprehensive analysis by seventeen authors was consulted. This volume, aptly titled _One World or None_,[34] includes articles by such scientists as Compton, Einstein, Langmuir, and Oppenheimer. It wisely states the problem, not the solution; any pretentious attempt to solve a problem of this complexity would be of little value now, although the keynote of a possible solution is seen in the title and constant reference to the necessity of "one world."

The literature cited has indicated the positions of education, science, and sociology on the socio-science relationship,

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[32] Associated Press dispatch, _The Boston Globe_, April 24, 1948.

[33] _Loc. cit._

[34] Dexter Masters and Katherine Way, Editors, _One World or None_ (New York: Whittlesey House, the McGraw-Hill Book Co., 1938), 79 pp.

but the attitudes of the science students who will take over responsible positions in all areas of science including atomic and biological research, has not been determined.

The attitudes of these individuals are of significant import; their determination of necessity to the nation.

CHAPTER III

MATERIALS AND METHODS USED IN THE STUDY

The real detonator of atomic and biological weapons is explosive human behavior. The neutralization of this 'detonator' can best be accomplished through education. The individuals used in this study have had considerable science education, which should have taught them the importance of man even with the presence of weapons which tend to dim the importance of the individual.

I. MATERIALS

Measurement of attitudes can never be wholly accurate and inflexible because of the constantly varying human element. However,an extensive survey of attitudes designed to draw out the nature of the individual's attitudes was administered as the experimental factor in this problem. Destructive scientific achievements were chosen because of their vital concern to our immediate future, and their significant and definable effect on attitudes. The following shows how they were selected: destructive achievements effective against military personnel alone were considered and discarded as weapons of immediate concern to participants, and of little or no definable effect on the attitudes of the group to be studied. The criterion decided upon for the selection of destructive achievements was

the weapon's potentiality to destroy civilization in a single concerted attack. This criterion assured a high degree of definable effect on the attitudes of thinking individuals toward the continuation of our civilization. Thus, the following destructive scientific achievements were chosen: the atomic bomb, stem rust, 'chain reaction' of germs, botulinus toxin, and psittacosis. The last four may be grouped as biological or germ warfare, and so the destructive scientific achievements were finally classified as the atomic bomb and biological warfare.

The survey of attitudes instrument. The face sheet of the 5-page survey instrument consisted of a short paragraph of instructions emphasizing that honest opinions are called for in subsequent responses. The fact that this survey was not a test was specifically stated; tests imply measurement of knowledge and correct or incorrect responses, while in a survey of attitudes there is no such thing as a right or wrong answer. Name, age, and similar background data were avoided to elicit freer responses.

To lessen the possibility that some individuals may have had varying amounts of background information on the atomic bomb and biological warfare, a brief statement of facts concerning these weapons, as derived from literature on the subject, completed the material on the face sheet and preceded the

body of the survey instrument. While this statement of facts describes only the consequences of the use of these destructive achievements, this can not be called a negative conditioner of attitudes for the following reasons: the problem was to note the effects of these weapons on the attitudes of the students; thus, a knowledge of the results of their use was necessary for the formation of realistic attitudes based on facts. Although these facts are unpleasant and negative in tone, they nonetheless exist and must be considered. Further, attitudes based on facts, whether positive or negative, are never conditioned attitudes.

The survey instrument per se consisted of two parts: Part I, comprising fifteen statements designed to elicit the positive or negative attitude pattern; and Part II, in which specific ideas, plans, and decisions of the students which resulted from the existence of the destructive weapons and the possibility of their use were called for.

Part I of the survey of attitudes instrument. This was a section containing fifteen statements, each one of which, excepting three statements to be grouped and scored with Part II, was either positively or negatively worded. A positively worded statement was one which was phrased in such a manner as to suggest that agreement with it implied the student's

positive attitude toward the continuation of our civilization, while disagreement implied a negative attitude toward the continuation of our civilization because of atomic and biological weapons, and resultant lack of confidence in his future. Similarly, agreement with a negatively worded statement implied a negative attitude, while disagreement with it implied a positive attitude.

Each of the fifteen statements was followed by five degrees of opinion; they ranged from the extreme pole of probably false, to possibly false, no opinion (undecided), possibly true, and to the other extreme pole of probably true. Arbitrary use of the absolute true and false was avoided, since the bulk of the statements were hypothetical or prophetic and not true and false, which implied right and wrong. However, the varying degrees of true and false which were used here indicated the desired subjective opinions which would reveal attitudes.

The three statements previously mentioned to be grouped and scored with Part II were statements two, eleven, and fourteen. These statements would not reveal a positive or negative attitude toward the continuation of our civilization, and should have been originally grouped with Part II or eliminated. However, instead of discarding them, they were grouped and scored with Part II, where they served to more clearly delineate

the attitude pattern through the supplementary opinions they elicited.

As previously stated, the fifteen statements (now twelve) in Part I were designed to create an over-all attitude pattern, but statements one and thirteen were actually the pith of the attitudes instrument; they were the statements which directly elicited the positive or negative attitudes toward the continuation of our civilization as worded in the statement of the problem. However, they were not weighted more heavily in the results than the other statements of Part I which were designed to supplement and more clearly delineate the attitude pattern set by the responses to statements one and thirteen.

Part II of the survey of attitudes instrument. This was a personal section designed to supplement the positive or negative attitudes revealed in Part I, and consisted of four questions (one, three, four, five), and a statement that was to be completed (two). For purposes of scoring, as well as reasons previously described, statements two, eleven, and fourteen of Part I were grouped with Part II. Of the original Part II, excluding the three statements of Part I, statement two and question five were concerned with the possible influence of atomic development on student choice of science, and present plans for their future in science. Questions one, three, and four were designed specifically to determine a degree of thought

and particularly overt activity resulting from the existence of the atomic bomb and biological warfare. This was an objective method (question and listed responses) of determining the subjective activity which in some cases resulted.

II. METHODS

Group used. The students used in this survey were advanced college science students at the junior, senior, and graduate levels in the fields of physics, chemistry, and biology. Advanced students were selected for the survey for two reasons: first, they are at this stage definitely committed to science, and their use as science students and later as scientists is therefore valid; secondly, the nature of science demands mature objectivity. This objectivity in weighing evidence is only gained with advanced studies, and is the first step in formulating an attitude.

The number of students used in this survey totaled 227, and were distributed among three Massachusetts higher institutions as follows: Boston University, 103; Massachusetts Institute of Technology, 56; and Harvard University, 68. The Boston University total of 103 included ten female students, and the Massachusetts Institute of Technology total of 56 included five female students. One of the Technology students used in this survey, a graduate student in chemistry, was formerly with

the Manhattan (atomic bomb) Project as a chemist. This brings a vital force to this problem, with views and attitudes based on actual experience associated with the atomic bomb.

Comparison among the three institutions to determine relative degrees of positive or negative attitudes among their students has no bearing on the present study, but is another problem including evaluation of teaching methods and similar factors. The value of this study is not derived through comparison, but in its presentation of certain attitudes which young scientists are bringing to science, and thus important to the nation.

The attitude patterns of the group studied will show the distribution of responses, and will be interpreted in the light of relative degrees of the positive or negative attitudes toward the continuation of our civilization. It is hoped that the availability of the results of this study will stimulate the utilization and discussion of topics of atomic energy and biological warfare at the high school level.

CHAPTER IV

SURVEY RESULTS

Although the individuals used in this study could logically be grouped as advanced science students, they individually represent conflicting patterns of influences, beliefs, and values, all of which affect their attitudes. Therefore, the group pattern for each statement which materialized out of this survey did not always present strong degrees of positive or negative response, but tended in some cases toward conservative degrees of possible agreement or disagreement. Nevertheless, this moderate trend is logical, since the attitudes are directed toward a situation which does not exist in concrete form, but simmers and awaits direction. This situation, the continuation of our civilization despite atomic and biological weapons, does not lend itself to scientific analysis and processes as we know them, but to socialized concepts.

Method of scoring Part I. For a survey of attitudes of this type, in which each statement has five responses which may be checked, Murphy and Likert[1] describe a sigma scoring method. Briefly, the sigma deviations were always taken from the mean, using Table 22 of Thorndike's Tables, which "... assume that one hundred per cent of the cases fall between

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[1] Gardner Murphy and Rensis Likert, Public Opinion and the Individual (New York:Harper and Bros.,1938), p. 40.

- 3 and + 3 sigma. The values given in the table are the average sigma values of intervals represented by the stated percentages, the origin considered to be at the mean."[2] However, they go on to describe a simpler method of scoring which correlated very well with the sigma method (+.99)[3]

In this method of scoring, which was the method of scoring used in this survey, values are assigned "from 1 to 5 to each of the 5 different positions on the 5- point statements."[4] Thus, in a positively-worded statement (implying confidence in the continuance of our civilization) a response of probably false was assigned a value of one, possibly false was assigned a value of two, no opinion or undecided was assigned value of three, possibly true was assigned a value of four, and the extreme agreement of probably true was assigned a value of five. Similarly, in a negatively-worded statement (implying lack of confidence in the continuance of our civilization), a response of probably false was assigned a value of five, possibly false

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[2] Loc. cit.

[3] Ibid., p. 62.

[4] Ibid., p. 44.

was assigned a value of four, no opinion or undecided was assigned a value of three, possibly true was assigned a value of two, and extreme agreement with a negative statement, probably true, was assigned a value of one. It will be seen that no opinion or undecided always carried a value of three, or midway between the two poles.

As mentioned in the previous chapter, statements two, eleven, and fourteen of Part I did not contribute to the attitude pattern, but were supplementary to this pattern in providing a clearer background to the opinions indicated on the other twelve statements. These three statements were grouped and scored with Part II of the survey.

Comments regarding the statements were not called for in this objective survey, but were added in a few cases, and they will be reported as a further aid to the understanding of the group's reasoning and attitudes.

Excluding statements two, eleven, and fourteen, the remaining twelve statements (nos. 1,3,4,5,6,7,8,9,10,12,13,15) were scored separately in the following manner: the nature of the statement was first determined; a statement was considered positive if it directly implied confidence in the continuance of our civilization even with the presence of atomic and biological weapons, and a statement was considered negative if it directly

implied lack of confidence in the continuance of our civilization because of the presence of atomic and biological weapons. As previously stated, statements one and thirteen were the key statements in actually stating the problem, and although not given greater weight in tabulation, they are worth noting as pertinent information.

The total response for each of the five possible positions to be checked on each statement was tabulated, and will be seen in Table I. Each position was multiplied by its appropriate value, as determined by the positive or negative nature of the statement. The actual score showing the relative degree of attitude was derived by adding the total scores of all five positions, and then dividing this by 227 (the total number of students used in survey as well as total response for each statement). This was in line with the method of scoring previously described, which explained that ... "since the number of statements was the same for all individuals, the sum of the numerical score rather than the mean was used."[5]

The resultant score had a possible range of 1.00 to 5.00; thus, a hypothetical score of 4.48 on a positive statement (values assigned from probably false [1] to probably true [5]) would show a high degree of positive attitude for the group,

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[5] *Ibid.*, p. 44 .

while the same score of 4.48 on a negative statement (values assigned from probably false (5) to probably true (1)) would show disagreement with a negatively-worded statement, and thus also indicate a positive attitude. Similarly, a hypothetical score of 1.53 on a positive statement (1 to 5) would show a high degree of negative attitude, while the same score of 1.53 on a negative statement would show disagreement with a negatively-worded statement (5 to 1) and thus also indicate a negative attitude. It will be seen from the above that, under this method of scoring, a score from 3.01 to 5.00 would indicate positive attitude and 2.99 to 1.00 negative attitude _regardless_ of whether the statement was positive or negative, since the value of 5 always was assigned to the positive end in both cases.

Results of Part I. The following tables were designed (1) to show the total response to each of the five choices on each of the twelve statements of Part I; (2) to show the responses multiplied by the assigned value, depending on whether the statement was positively or negatively worded; and (3) to present a score from 1.00 to 5.00 derived through adding the sums of the total responses multiplied by the value for each response, and dividing by 227. These resultant scores were used as the basis for subsequent interpretation of results.

TABLE I

DISTRIBUTION OF RESPONSES TO THE TWELVE STATEMENTS OF PART I

		PROBABLY FALSE	POSSIBLY FALSE	NO OPINION OR UNDECIDED	POSSIBLY TRUE	PROBABLY TRUE
STATEMENT	1	149	27	1	45	5
	3	117	65	1	28	16
	4	28	9	15	82	93
	5	93	42	13	37	42
	6	40	27	27	74	59
	7	59	42	28	45	53
	8	173	25	20	6	3
	9	44	23	37	53	70
	10	97	36	29	28	37
	12	188	17	8	8	6
	13	19	22	20	89	77
	15	110	42	15	29	31

RESPONSES (TOTAL: 227)

NOTE: STATEMENTS 2, 11, and 14 WILL BE GROUPED AND SCORED WITH PART II OF THIS SURVEY.

TABLE II

ASSIGNMENT OF APPROPRIATE VALUES TO RESPONSES, WITH FINAL SCORE FOR EACH STATEMENT

STATEMENT	PROBABLY FALSE		POSSIBLY FALSE		NO OPINION OR UNDECIDED		POSSIBLY TRUE		PROBABLY TRUE		SCORE FOR STATEMENT	NATURE OF STATEMENT*
1	149.5	745	27.4	108	1.3	3	45.2	90	5.1	5	4.18	-
3	117.5	585	65.4	260	1.3	3	28.2	56	16.1	16	4.05	-
4	28.1	28	9.2	18	15.3	45	82.4	328	93.5	465	3.89	+
5	93.5	465	42.4	168	13.3	39	37.2	74	42.1	42	3.47	-
6	40.1	40	27.2	54	27.3	81	74.4	296	59.5	295	3.37	+
7	59.5	295	42.4	168	28.3	84	45.2	90	53.1	53	3.04	-
8	173.5	865	25.4	100	20.3	60	6.2	12	3.1	3	4.58	-
9	44.1	44	23.2	46	37.3	111	53.4	212	70.5	350	3.36	+
10	97.5	485	36.4	144	29.3	87	28.2	56	37.1	37	3.56	-
12	188.5	940	17.4	68	8.3	24	8.2	16	6.1	6	4.64	-
13	19.1	19	22.2	44	20.3	60	89.4	356	77.5	385	3.81	+
15	110.5	550	42.4	168	15.3	45	29.2	58	31.1	31	3.76	-

RESPONSES . VALUE

*
+ POSITIVE STATEMENT
- NEGATIVE STATEMENT

Summary of Part I results. The response to each statement, an analysis of the response, and a conclusion for each statement in the light of the problem, all amplified with student comments anent several of the statements will constitute the summary of the results of Part I; interpretation and conclusions will be dealt with in the next chapter.

STATEMENT ONE: "The atomic bomb will wipe out all traces of our civilization within a few years."

Nature of statement: The nature of this statement was negative and its large negative response made the score for the statement 4.18 out of a possible 5.00.

Analysis of response: This indicated a high degree of lack of concurrence with a negative statement, and thus showed that the group to a strong degree does not believe the atomic bomb will destroy our civilization within a few years.

Conclusion for statement: This clearly indicates a positive attitude toward the continuation of our civilization and an expression of student confidence in their future.

Student comment: none.

STATEMENT THREE: "There is little an individual can do about what is going to happen to this world, even if he organizes into strong groups which can voice opinions."

Nature of statement: The nature of this statement was negative, and its large negative response made the score for the statement 4.05 out of a possible 5.00.

Analysis of response: This indicated a high degree of lack of concurrence with a negative statement, and thus showed that the group to a fairly strong degree believes that the individual can make his presence felt and take part in shaping world affairs.

Conclusion for statement: This indicates a positive attitude toward the continuation of our civilization in its implication that individuals dictate the pattern of events.

Student comment: possibly false - "He can under U. S. type democracy."

STATEMENT FOUR: "Writing to the congressmen who help to shape our foreign policy is worthwhile."

Nature of statement: The nature of this statement was positive, and its moderately positive response made the score for the statement 3.89 out of a possible 5.00.

Analysis of response: This indicated a moderate degree of concurrence with a positive statement, and thus showed that the group to a moderate degree believes that, as an active manifestation of the previous statement, the writing to congressmen is a worthwhile individual contribution to better international harmony.

Conclusion for statement: This indicates a positive attitude toward the continuation of our civilization in its emphasis on individual endeavor as an expression of confidence in the future.

Student comment: none.

STATEMENT FIVE: "The existence of the atomic bomb and the possibility of germ warfare means that the present time is the last chance for one united world."

Nature of statement: The nature of this statement was negative, and its negative response midway between no opinion and possibly false made the score for the statement 3.47 out of a possible 5.00.

Analysis of response: This indicated a fairly moderate degree of lack of concurrence with a negative statement, and thus showed that the group to fairly moderate degree does not believe that the

atomic bomb and germ warfare mean that the present time is the last chance for one united world.

Conclusion for statement: This indicates a positive attitude toward the continuation of our civilization in its implication that we may achieve a united world without these weapons ever being used to force a showdown of a situation which should be arrived at through rational processes.

Student comment: possibly true - "In the civilization we know, at least."

STATEMENT SIX: "The United Nations has a good chance of succeeding if, instead of conflicts, points of agreement among nations are emphasized."

Nature of statement: The nature of this statement was positive, and its slightly moderate positive response made the score for the statement 3.37 out of a possible 5.00.

Analysis of response: This indicated a slightly moderate degree of concurrence with a positive statement, and thus showed that the group to a slightly moderate degree believes that the United Nations has a good chance of succeeding if, instead of conflicts, points of agreement among nations are emphasized.

Conclusion for statement: This indicates a positive attitude toward the continuation of our civilization in its expression of confidence in the potential ability of the United Nations to succeed as an instrument working toward international cooperation and world peace. This also supports the corollary of the group's expression of confidence in their future.

Student comment: possibly true - "Debate and compromise backed by potential strength must reign until all parties gain confidence and experience in working together."

STATEMENT SEVEN: "The United Nations will never work unless it has a strong military force which will use the atomic bomb, if necessary, to keep every country in line."

Nature of statement: The nature of this statement was negative, and its extremely moderate negative response made the score for the statement 3.04 out of a possible 5.00.

Analysis of response: This indicated a slight degree of lack of concurrence with a negative statement, and thus showed that the group to a slight degree does not believe that the United Nations must utilize the threat of the atomic bomb to create international harmony.

Conclusion for statement: This indicates a positive attitude toward the continuation of our civilization in its implication that punitive measures will never bring about the willing cooperation which is necessary to world peace.

Student comment: probably false - "The U. N. will never work until it becomes a world government in fact."

STATEMENT EIGHT: "Since most of our present social environment is bad, some good may come of the atomic bomb if it wipes out most of the society, and forces us to start anew."

Nature of statement: The nature of this statement was negative and its large negative response made the score for the statement 4.58 out of a possible 5.00.

Analysis of response: This indicated a very high degree of lack of concurrence with a negative statement and thus showed that the group to a strong degree does not believe that the atomic bomb would have value in forcing the creation of a new society.

Conclusion for statement: This clearly indicates a positive attitude toward the continuation of our civilization in its implication that when all people constantly strive to improve society it is a strong

positive approach; negative approaches usually engender negative results.

Student comment: none.

STATEMENT NINE: "It is not the social environment, but the people living in it who determine the patterns in which events will take place."

Nature of statement: The nature of this statement was positive, and its slightly moderate positive response made the score for the statement 3.36 out of a possible 5.00.

Analysis of response: This indicated a slightly moderate degree of concurrence with a positive statement, and thus showed that the group to a slight degree believes that it is the people living in a social environment who determine the patterns in which events will take place. A higher degree of concurrence was obviated by the failure to provide the statement that people's behavior depends on their environment, as was summed up in student comment.

Conclusion for statement: This indicates a positive attitude toward the continuation of our civilization and confidence in the future through concurrence with the thought that the individual still controls weapons which may destroy him, and that it is his

common sense which must guide their utilization.

Student comment: Probably true - "But the people are to a large extent restricted by their past and present environment."

STATEMENT TEN: "The United States is the only country that can be trusted with the atomic bomb, and to share the secrets of its manufacture may be disastrous to us."

Nature of statement: The nature of this statement was negative, and its negative response midway between no opinion and possibly false made the score for the statement 3.56 out of a possible 5.00.

Analysis of response: This indicated a fairly moderate degree of lack of concurrence with a negative statement, and thus showed that the group to a fairly moderate degree believes that other countries are capable of being trusted with the atomic bomb without using it on this or other countries.

Conclusion for statement: This indicates a positive attitude toward the continuation of our civilization in its implication of a healthy, matured trust of other nations as a first step toward international cooperation and peace.

Student comment: probably false - "It may be just as disastrous not to share it." possibly true - "By sharing with less matured countries before they have learned to live at peace would be disastrous."

STATEMENT TWELVE: "Fate determines a large share of everything that takes place, so we may as well resign ourselves to probable destruction."

Nature of statement: The nature of this statement was negative, and its very large negative response made the score for the statement 4.64 out of a possible 5.00.

Analysis of response: This indicated an extremely high degree of lack of concurrence with a negative statement, and thus showed that the group to a very strong degree does not believe fate determines a large share of everything that takes place, including probable destruction from atomic and biological weapons.

Conclusion for statement: This clearly indicates a positive attitude toward the continuation of our civilization and an expression of confidence in the future, as well as amplifying the conclusion that the individual in this study considers himself the director of his own destiny.

Student comment: none.

STATEMENT THIRTEEN: "Common sense and reason will prevail, and the atomic bomb and germ warfare will never be utilized for destructive purposes."

Nature of statement: The nature of this statement was positive, and its moderately positive response made the score for the statement 3.81 out of a possible 5.00.

Analysis of response: This indicated a moderate degree of concurrence with a positive statement, and thus shows that the group to a moderate degree believes that the atomic bomb and germ warfare will never be utilized for destructive purposes.

Conclusion for statement: This indicates a positive attitude toward the continuation of our civilization and its resultant confidence in the future, in spite of weapons which are capable of shattering our civilization.

Student comment: none.

STATEMENT FIFTEEN: "Wars and destruction among men are unavoidable and should be accepted as part of our civilization."

Nature of statement: The nature of this statement was negative, and its moderately negative response made the score for the statement 3.76 out of a possible 5.00.

Analysis of response: This indicated a moderate degree of lack of concurrence with a negative statement, and thus shows that the group to a moderate degree does not believe that wars and destruction among are unavoidable and should be accepted as part of our civilization.

Conclusion for statement: This indicates a possitive attitude toward the continuation of our civilization and confidence in the future, as well as the implication that wars can be avoided, and are not a necessary adjunct to our civilization.

Each statement, together with student comments pertaining to it, has been discussed and analyzed in the light of the problem; to determine the extent to which the atomic bomb and biological warfare influence the nature of attitudes of the group studied toward the continuation of our civilization and resultant confidence toward the future.

TABLE III

STATEMENTS RANKED IN ORDER OF CERTAINTY AS BASED ON SCORE FOR STATEMENT

Rank	Statement no.	Nature of statement	Score for statement
1	12	NEGATIVE	4.64
2	8	NEGATIVE	4.58
3	1	NEGATIVE	4.18
4	3	NEGATIVE	4.05
5	4	POSITIVE	3.89
6	13	POSITIVE	3.81
7	15	NEGATIVE	3.76
8	10	NEGATIVE	3.56
9	5	NEGATIVE	3.47
10	6	POSITIVE	3.37
11	9	POSITIVE	3.36
12	7	NEGATIVE	3.04

Method of scoring Part II. Part II of this survey was designed as a corollary to the attitudes to be elicited in Part I. It contained four questions and one statement which were to be answered in an objective manner by the checking of possible answers plus the space provided for other answers to be specified. The three statements from Part I of the survey which did not contribute to the positive or negative attitude pattern (2, 11, 14) were grouped with Part II and scored in a similar manner. The total of four questions and four statements of Part II were scored by distributing the responses among the possible answers and computing the percentage of responses for each answer on the total basis of 227. The resultant percentages lend themselves to more accurate interpretation of Part I through their presentinga background pattern for attitudes and possible future overt activity as a result of these attitudes.

Results of Part II. The following figure and table were designed (1) to show a copy of the page of the survey containing Part II, with responses and percentages for each answer filled in; and (2) to show the responses and percentages for each of the five positions of statements two, eleven, and fourteen of Part I.

Figure 1

Distribution and percentages of responses to Part II

Part II - Check the word or statement which best fits your situation.

1. Have you ever thought about the possible effects of the atomic bomb and biological warfare on you and your future life?

   48.9% 48.1%

   never(1).4%sometimes(111)often(109)constantly.(6)2.6%

2. The rapid progress in atomic development was a factor in your choosing science as your life's work,

   a. because it opened vast new fields of research(17).7.5%
   b. because it demonstrated the control of science over our lives.(3)1.3%
   c. because it seemed a thrilling type of work with which to be associated.0...
   d. because it first called your attention to the importance of science.(2). .9%
   e. not at all..(205) 90.3%

3. Has the invention of the atomic bomb and the possibility of its use made you hesitate to make any of the following plans for your future?

   a. marriage.(8)3.5%
   b. children.(12)5.3%
   c. banking money.(3). 1.3%
   d. further schooling(1)..4%
   e. owning your own home.(3). 1.3%
   f. others (specify).none (191) 84.2%
   g. plan my future around a manufacturing center (7) 3.1%
   h. choice of company or organization at which to work (2) .9%

4. Has the invention of the atomic bomb and the possibility of its use made you decide to make any of the following plans for your future?

   a. changing residence to another section of this country.(12) 5.3%
   b. living abroad.0...
   c. enlisting in the armed forces...0.
   d. remaining single.(2). .9%
   e. if married, not to have children.0...
   f. others (specify)none (208) 91.6%
   g. further my schooling or study harder (5) 2.2%

5. Which of the following represents your present plans for your future in science?

   a. Remain in the same field in science and enter:
      Teaching(59) 26.0%
      Research..(86) 37.9%
      Graduate Study(34) 15.0%
      Foreign Study.0..
      Application of your field in science to other types of work.(44). 19.4%
   b. Change to another field in Science.(2). .9%
   c. Change to a field other than science..(1) .4%
   d. Leave School.0...
   e. Others (Specify)..medical missionary (1) .4%

TABLE IV

DISTRIBUTION AND PERCENTAGES OF RESPONSES TO STATEMENTS 2, 11, & 14 OF PART I

STATEMENT	PROBABLY FALSE	POSSIBLY FALSE	NO OPINION OR UNDECIDED	POSSIBLY TRUE	PROBABLY TRUE
2	(129) 56.8%	(31) 13.7%	(5) 2.2%	(47) 20.7%	(15) 6.6%
11	(49) 21.6%	(11) 4.8%	(45) 19.8%	(43) 19.0%	(79) 34.8%
14	(186) 82.0%	(19) 8.3%	(11) 4.8%	(3) 1.3%	(8) 3.5%

RESPONSE & PERCENTAGE

NOTE: These three statements have been grouped and scored with Part II, since they are background material like Part II, and do not directly contribute to the positive or negative attitude pattern of Part I.

Summary of Part II results. The response and percentage of response to each choice of the original three questions and one statement of Part II plus the three added statements of Part I will constitute the summary of the results of Part II; interpretation and conclusions will be dealt with in the next chapter.

Part II was generally designed to determine overt activity as a result of the existence of the atomic bomb and biological warfare; thus, in line with the completely positive attitude as derived through part I, there should only be a small degree of intended overt activity as a result.

QUESTION ONE: Concerning the question "Have you ever thought about the possible effects of the atomic bomb and biological warfare on you and your future life?", the distribution of response was almost equally between "sometimes" (48.9%) and "often" (48.1%), with the .4% for "never" and 2.6% for "constantly" serving to sway the balance in favor of often.

Conclusion: The existence and potential utilization of atomic and biological weapons has caused this thinking group of students to consider the possible effects of these weapons on themselves and their future life many times.

STATEMENT TWO: "The rapid progress in atomic development was a factor in your choosing science as your life's work," was followed by five possible responses, with "not at all" receiving a response of 205 out of 227, for a percentage of 90.3%. The reason "because it opened vast new fields of research" received a response of seventeen, for a percentage of 7.5%. Three students (1.3%) responded "because it demonstrated the control of science over our lives." Two students (.9%) responded "because it first called your attention to the importance of science." Conclusion: The rapid progress in atomic development was overwhelmingly not a factor in this group's choice of science as a life's work. An obvious explanation would be that news of atomic energy and its potentialities was withheld from public consumption until after the dropping of the first atomic bomb in August of 1945. At that time, many of the group studied were in the armed forces, and those in college at the time were either committed to science for other reasons, not at all, or just beginning a college program. Some of this latter group were among the juniors who took this survey, and comprised the total of 9.3% which considered atomic development a factor in their choice of science.

QUESTION THREE: This was designed to consider possible overt activity as a result of the atomic bomb, and was worded as follows: "Has the invention of the atomic bomb and the possibility of its use made you hesitate to make any of the following plans for your future? "The response of "none" was cited 191 times for a percentage of 84.2%. Others were "marriage" 3.5%, "children" 5.3%, "banking money" 1.3%, "further schooling .4%, "owning your own home" 1.3%, "plan my future around a manufacturing center" 3.1%, and "choice of company or organization at which to work" .9%. The Massachusetts Institute of Technology research assistant and graduate student in chemistry who was a former Manhattan (atomic bomb) Project employee as a chemist checked this latter response even though his overall attitude as elicited from Part I of the survey was a score of 4.0 out of 5.0, or a positive attitude to a high degree.

Conclusion: Bearing in mind the positive attitude of the group on every statement of part I, this reveals consistency, since only 15.8% of the group has even hesitated to make plans for their future as a result of the atomic bomb.

QUESTION FOUR: This was designed to consider definite overt activity undertaken as a result of the atomic bomb, and was worded as follows: "Has the invention of the atomic bomb and the possibility of its use made you decide to make any of the following plans for your future?" A response of "none" was cited 208 times, for a percentage of 91.6%. Others were "changing residence to another section of this country" 5.3%, "further my schooling or study harder" 2.2%, and "remaining single" .9%.

Conclusion: The positive attitude of the group toward the continuation of civilization, as revealed in the results of Part I, should engender a low degree of expressed overt activity. The total response of 8.4% overt activity decided on as a result of the atomic bomb is consistent with this positive attitude.

QUESTION FIVE: This was designed to note what the group planned to do with their science in the future, and was worded as follows: "Which of the following represents your present plans for your future in science?" Response 'a' was to "Remain in the same field in science and enter:" included five possibilities: these were "teaching" 26.0%, "research" 37.9%, "graduate study" 15.0%, "foreign study" 0%, and "application of your field in science to other types of work" 19.4%. Other responses were

"change to another field in science" .9%, "change to a field other than science", .4%, "Leave school" 0%, and "others (specify)", which brought one response of medical missionary .4%.

The three statements (2, 11, 14) of Part I have been grouped and scored with Part II by percentage of response.

STATEMENT TWO: "Scientists will control the destiny of the world because of their ability to create destructive weapons."

Response to statement: The response of "probably false" was checked by 129 students (56.8%); the response of "possibly false" was checked by 31 students (13.7%); the response of "no opinion" or undecided was checked by 5 students (2.2%); the response of "possibly true" was checked by 47 students (20.7%); and the response of "probably true" was checked by 15 students (6.6%).

Conclusion: The group to a moderate degree does not believe that the ability of scientists to create weapons which are capable of destroying our civilization has placed them in a position to directly shape world policy. A logical explanation of this is possibly because scientists no longer decide the utilization of their discoveries which have military significance.

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STATEMENT ELEVEN: "If called on to fight for this country in another war, you would volunteer if you felt that you really understood and believed in the reason why another war might be necessary."

Response to statement: The response of "probably false" was checked by 49 students (21.6%); the response of "possibly false" was checked by 11 students (4.8%); the response of "no opinion" or undecided was checked by 45 students (19.8%); the response of "possibly true" was checked by 43 students (19.0%); and the response of "probably true" was checked by 79 students (39.8%).

Conclusion: The total of 53.8%for the two 'true' positions, but only 26.4% for the two 'false' positions raises an interesting point; the large undecided response of 19.8% indicates a group which either has not, will not, or hesitates to think about its role in the event of another war. Their suspended judgment in a matter whose consequences are possible destruction for all indicates a rational mind; do all you can to prevent war, but do not approach it from the negative viewpoint (except noting its consequences), which is remedial instead of preventive. The total of 53.8% in agreement with the statement indicates the group would be slightly in favor of volunteering if they understood and really believed in the reason

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why another war might be necessary. The restriction to any valid conclusion in regard to this statement is the large undecided group.

Student comment: "If another war starts, humanity has lost its chance. Of course, then one would fight for self-preservation."

STATEMENT FOURTEEN: "Science and scientists should be condemned for creating the atomic bomb and biological warfare."

Response to statement: The response of "probably false" was checked by 186 students (82.0%); the response of "possibly false" was checked by 19 students (8.3%); the response of "no opinion" or undecided was checked by 11 students (4.8%); the response of "possibly true" was checked by 3 students (1.3%); and the response of "probably true" was checked by 8 students (3.5%).

Conclusion: The overwhelming response in disagreement with the statement (90.3%) clearly indicates the position of the group in regard to science's role in creating weapons which can destroy our civilization.

The logic of this reasoning is that although man now has the forces to obliterate himself, it will only be through his own folly that he will do so. The creators of the forces are absolved of blame if man will not con-

trol them. Then, too, military control and utilization of destructive weapons has rendered not the scientists, but the military liable to condemnation for any possible utilization.

In the next chapter, the results will be interpreted in the light of science education's role, summarized, and finally certain conclusions as derived from this study will be drawn; the resultant amalgam of the attitudes of the group studied will suggest further study along these lines as work of importance to the nation in the atomic age.

CHAPTER V

SUMMARY AND CONCLUSIONS

The existence of the atomic bomb and biological warfare has engendered positive or negative attitudes toward the continuation of our civilization. In the group studied, consisting of 227 advanced science students, the nature of responses has indicated degrees of these attitudes which were used as the basis for the forthcoming summary and conclusions.

Summary. An analysis of the twelve statements of Part I shows one striking fact: every statement received a score indicating a positive attitude to varying degrees by the group toward the continuation of our present civilization, in spite of weapons which are capable of destroying this civilization. The degrees of this positive attitude ranged from slightly moderate (3.04) on statement seven, to extremely high (4.64) on statement twelve, with the maximum positive agreement being a score of 5.00. The response to statement twelve showed the group to be in high agreement with man's free will, and not the negative fatalism school of thought. In regard to statements three and four, concerning the part the individual and public opinion play in the shaping of governmental policy and world events, the moderately high degree of positive attitude of the

group is in accord with Bailey's[1] thorough consideration and evaluation of the positive impact of American public opinion on the shaping of foreign policy.

Statements one and thirteen, which directly elicited the nature of attitudes toward the continuation of our civilization as worded in the statement of the problem, brought moderately high (4.18 and 3.81) positive scores which indicated the group to have a moderately high degree of confidence in their future.

In regard to Part II, the results have showed the extent of the influence of the atomic bomb and biological warfare on the personal life and preparation for the future of the group studied. A composite student set up as a result of the responses to Part II would be as follows: he thinks often about the possible effects of the atomic bomb and biological weapons on himself and his future life, but has not materially altered any plans for his future as a result of the weapons, although he has hesitated slightly in certain plans; he chose science without atomic development being a significant factor, and at the present time plans to do research, with the possibility of teaching or industry after that if research does not remain the permanent phase of his career in science.

Conclusions. Thurstone and Chave[2] have pointed out that

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[1] Thomas A. Bailey, The Man in the Street (New York: The Macmillan Company, 1948), 334 pp.

[2] L.L. Thurstone, and E. J. Chave, The Measurement of Attitude (Chicago: University of Chicago Press, 1937), 96 pp.

"The measurement of attitudes expressed by a man's opinion does not necessarily mean the prediction of what he will do."[3] This implies overt activity as the criterion for the strength of an attitude. Thus, Elliott and Merrill[4] state that, "The nature of the attitude can be roughly measured by the character of the overt activity it calls forth."[5] Similarly, Allport[6] believes that, "An attitude characteristically provokes behavior that is ... affirmative _or_ negative toward the object ... with which it is related. This double polarity in the _direction_ of attitudes is often regarded as their most distinctive feature."[7] In regard to overt activity as a result of an extremely negative attitude, there have been newspaper reports of suicides by individuals who left notes indicating they preferred this method of death to the consequences of atomic and biological warfare. In the group studied, however, the positive attitude has had as

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[3] _Ibid._, p. 9.

[4] Mabel A. Elliott, and Francis E. Merrill, _Social Disorganization_ (revised edition; New York: Harper and Bros. Publishers, 1941), 1087 pp.

[5] _Ibid._, p. 37.

[6] Gordon W. Allport, "Attitudes," _A Handbook of Social Psychology_ (Carl W. Murchison, Editor; Worcester, Massachusetts: Clark University Press, 1935), 1195 pp.

[7] _Ibid._, p. 819.

its concomitant a clear indication of strong faith and confidence in the future in spite of atomic and biological weapons.

Probable effects on science education. What is to be the function of science education in regard to the shaping of attitudes which are partially derived and formulated through classroom activity? This study has specifically considered student attitudes toward the continuation of our civilization; concerning this and science education, the literature ranges from the highly pessimistic philosophy of a race between education and catastrophe, to the rational analysis that:

> Science, with its products, ... methods, and ... ways of developing belief in facts, in truth, in dependability, and in things that endure, is a major determining element in our civilization. Science education, therefore, seems imperative if society seeks security. Yet science education cannot guarantee security. Security rests not only in men's knowledge but in their characters. The will to do what is right transcends knowledge of how to do what is right. Science may contribute knowledge and understandings. Their ways of working may exhibit the unprofitableness of errors, but educated human character must assume the decisive role in civilization's future.[8]

The significant point in the discussion of the impact of the destructive weapons on science education is so very basic that it may be overlooked, but the point hits home and should be considered carefully; that is, science education is only one

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[8] Science Education in American Schools, Forty-Sixth Yearbook of the National Society for the Study of Education, Part I, 1947. pp. 295-6.

facet with which to combat atomic and biological weapons and their frequently negative effects on attitudes. Science education must work with religion, society, and government to fight any possible negative attitudes toward the continuation of our civilization by the mass of our populace, who are floundering in uncertainty and anxiety, and must be buttressed by faith and work. Science education alone cannot do this; the press, the pulpit, and the roundtable discussion must share the burden and stimulate man to broaden the areas of his thinking. But science education has a unique task; it deals with malleable personalities who are in the process of creating their individual thought and behavior patterns, and who utilize the classroom situation for a large share of their experiences.

To the advanced science student, science education would make a maximum contribution by presenting facts and suggesting implications, but allowing the student to form his own attitudes; i. e., present facts on atomic energy and its potentialities, but do not influence student attitudes. Reflective thinking by the student is the medium by which he should formulate his own attitude; the essence of its worth rests on the fact that the attitude has been personally derived.

Agreement with this suggests further implications; the science instructor must be informed of the social implications of the atomic bomb and biological warfare, and recognize their

importance. Further, he should stimulate discussion of these implications to make the student keenly aware of all the known factors. Finally, he should logically integrate the discussion with existing social values. Each of these steps is an incentive to the advanced science student to formulate his own hypotheses, conclusions, and finally derive the attitude through reflective thought.

The results of this study suggest, in addition to the previously discussed broader implications, further changes which should be made in science education.

Suggested changes in science education. (based on the results of this survey).

1. Include a unit or topic on atomic energy and biological warfare in the secondary curriculum. Since this survey has shown that science students often think about the effects of the atomic bomb and biological warfare on themselves and their future life, the preparation for reflective thought should be initiated in the secondary school; as the students at this level become increasingly aware of the implications of atomic energy, they should have adequate factual instruction in this regard to serve as a worthwhile base from which to formulate subsequent attitudes.

2. While a minor percentage of science students will attend college and devote their lives to science, nevertheless science education has an equal obligation to the majority who will never enter the fields of science. This statement should be based on the following premise: all of the individuals who are affected by science education will enter society and make their presence known through votes and opinions; thus, the individual who studied science solely because it was a requirement or elective nevertheless will receive instruction on the potentialities of atomic and biological warfare and their social implications; and, the positive or negative attitude pattern which he will contribute to society will have been nurtured along with the attitudes of the potential scientist. While the attitudes of the group studying but not entering science may not be of as direct, vital influence on this nation as are the attitudes of the potential scientists, the instructor should emphasize social implications to both groups, and realize the powerful influence the general public has in the shaping of our national policy.

3. Science education should set-up and encourage vigorous participation in workshops devoted to atomic energy and biological warfare from the secondary level science clubs through collegiate and graduate discussion groups. This would extend its scope to interest individuals who may have previously been unconcerned about what the individual could do.

4. The fields of science should make available trained lecturers (teachers, professors, research personnel) to community roundtable discussions and radio broadcasts to stimulate wider participation in the problem of atomic energy and biological warfare and their relation to the individual. Television could be employed to tremendous advantage in presenting facts on atomic energy and biological warfare through this visual aid medium to a heretofore unreachable audience.

5. The slightly moderate positive response (3.36) to statement nine of Part I of the survey instrument, "It is not the social environment but the people living in it who determine the patterns in which events will take place," suggests a further task for science education; point out how the individual

and the group may determine the patterns of events, and constantly emphasize man's free-will. When science education has inculcated into the student a clear, working philosophy of man's free will, importance, and continued existence even with the presence of atomic and biological weapons, then it has rendered a great service to the individual and to society; faith, planning, and working with confidence in the future will be the result.

6. The slightly moderate positive response (3.37) to statement six of the survey instrument, "The United Nations has a good chance of succeeding if, instead of conflicts, points of agreement among nations are emphasized," suggests another task for science education; when considering social implications, ramify the discussion to include the structure and function of the United Nations and why this organization must succeed. There should be no limit to the scope of social implications; the instructor must consider as his area of instruction as much of human experience that is necessary to amplify the discussion and whet the intellectual appetite.

7. In regard to statement two of Part II of the survey instrument, "The rapid progress in atomic development was a factor in your choosing science as your life's work," the nature of responses pose certain implications for science education, since 17 students (7.5%) in this survey checked the response "because it opened vast new fields of research," this indicates that atomic energy may initiate appeal for a moderate percentage of the group to consider science as a life endeavor. It is reasonable to assume that this would be operative to an even stronger degree in the secondary school, where most students are still undecided concerning future plans and life endeavor. If this is the case, then the science instructor should utilize the tremendous potentialities connected with atomic development to encourage worthy students to consider science and possibly atomic energy as a life endeavor. As a corollary, science education should resist any emphasis on the glory or thrills of working on atomic projects, in line with finding in this study that no student chose science as his life's work because atomic development had keynoted science as a thrilling type of work with which to be associated, and

on the fact that it just is not true.

8. In regard to question three of Part II of the survey instrument, "Has the invention of the atomic bomb and the possibility of its use made you hesitate to make any of the following plans for your future?", the nature of responses suggest certain procedures for science education; the 8.8% response to "marriage" (3.5%), and "children" (5.3%), indicates a moderate percentage of the group has allowed the devastating potentialities of atomic and biological warfare to create hesitancy regarding normal biological functions of man. Both as a matter of personal regard for the student and for the nation, science instruction should show why nothing should frustrate normal functioning, ideals, and plans for the future which are the heart of the modern American family. The sociological pattern of human relations in this country is built on the family unit; science education must also make this clear from the biological viewpoint.

9. In regard to question four of Part II of the survey instrument, "Has the invention of the atomic bomb and the possibility of its use made you decide to make any of the following plans for your future?",

the nature of responses once again suggest certain procedures for science education; the fact that twelve students (5.3%) checked the response "changing residence to another section of this country" means that science education should utilize preventative measures to stem any similar incipient trend toward a minority negative attitude of this sort; these measures could be in the form of suggesting more faith in the future and harder work by the individual to achieve a sustained positive attitude, the strength of which would preclude the desperate consideration of flight as a result of a negative attitude. If the science instructor finds a similar small negative tone running through the larger positive attitude of the group, he could break up the class into small discussion groups, in which other students of the group will point out to the individual who has negative attitude tendencies just why the majority feels as it does; this will be more effective than an instructor consciously or unconsciously putting pressure on the student to submit to the group's majority opinion. Then, too, the objective previously mentioned of the stimulation of reflective thought can hardly be aided by

insisting on the dissident conforming to the majority; nor can this insistence be compatible with the scientific attitude.

The fact that five students (2.2%) checked the response "further my schooling or study harder" as a definite result of atomic potentialities suggests definite procedures to science education; show the student why a maximum amount of education is necessary to the student and to the nation in the atomic age. This atomic age has brought with it new and increased demands on the individual; it is a challenge and a responsibility he cannot ignore.

Everyone's attitude toward the continuation of our civilization must be based on the belief that we can abolish war, because without that belief we will blow ourselves and our civilization into drifting dust. And, if intelligence can create the means by which all civilization as we know it can suddenly end, that same intelligence, backed by the spiritual and educational forces of manking, can bring our technology under control and make it the servant and not the master of man.

Suggestions for further study. Among studies which would complement and amplify the present study would be the following: Within the next few years, determine the extent of the influence of atomic and biological weapons as the factor which

caused students to enter science; evaluate overt activity as well as degree and direction of change over a certain period of time as a result of the tension accompanying atomic and biological weapons which will be possessed eventually by other nations; conduct a nation-wide survey to determine the relative degree of attitudes on a regional basis; and finally, evaluate the role of science education in regard to attitudes concerning the atomic bomb and biological warfare by determining the effects of these weapons on teachers in service.

BOSTON UNIVERSITY

GRADUATE SCHOOL

An Abstract of a Thesis

THE EFFECTS OF THE ATOMIC BOMB AND BIOLOGICAL WARFARE ON THE ATTITUDES OF COLLEGE SCIENCE STUDENTS

by

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An Abstract of a Thesis

THE EFFECTS OF THE ATOMIC BOMB AND BIOLOGICAL WARFARE ON THE ATTITUDES OF COLLEGE SCIENCE STUDENTS

The scientists who create destructive weapons such as the atomic bomb and biological warfare have helped to produce positive or negative attitudes in most thinking individuals as to the continued existence of our civilization. It was, therefore, the purpose of this study to determine the extent to which the atomic bomb and biological warfare influence the attitudes of the group studied, which consisted of 227 advanced college science students at the junior, senior, and graduate levels in the fields of chemistry, biology, and physics. The attitudes engendered were a positive attitude on the one hand that our present civilization will continue in spite of the atomic bomb and biological warfare, and a negative attitude on the other hand that these destructive scientific achievements will fulfill their potential and destroy our civilization.

The methods instrument used to determine the attitudes was a survey of attitudes. This survey of attitudes instrument contained (1) a statement of facts concerning the destructive potentialities of the atomic bomb and several outstanding and deadly forms of biological or germ warfare; (2) Part I, comprising fifteen statements designed to elicit the positive or

negative attitude pattern; and (3) Part II, in which specific ideas, plans, and decisions of the students which resulted from the existence of the destructive weapons and the possibility of their use were called for. The statements in Part I were followed by five responses: probably false, possibly false, no opinion, or undecided, possibly true and probably true. If the statement was positively worded (implying confidence in the continuation of our civilization), the values used in scoring were assigned in the following manner: a response of probably false received a value of one, a response of possibly false received a value of two, a response of no opinion or undecided received a value of three, a response of possibly true received a value of four, and a response of probably true received a value of five. Similarly, in a negatively worded statement (implying lack of confidence in the continuation of our civilization), the values were reversed; probably false received a value of five, graded to the response of probably true, which received a value of one. The total response for each of the five possible positions to be checked on each statement was tabulated. Each position was multiplied by the positive or negative nature of the statement. The actual score showing the relative degree of attitude was derived by adding the total scores of all five positions, and then dividing this by 227 (total number of students used in the survey as well as total response for each statement. The

resultant scores for each statement of Part I ranged from 3.04 to 4.64. This indicated varying degrees of positive attitudes toward the continuation of our civilization, and showed that the group studied definitely had a positive attitude toward the continuation of our civilization, despite the atomic bomb and biological warfare.

Part II was designed to supplement the attitude pattern derived from the results of Part I by determining the number and percentages of intended overt activity as a result of the atomic bomb and biological warfare. The results of Part II were completely consistent with the results of Part I, insofar as the positive attitude revealed in Part I had as its concomitant a very low degree of intended overt activity as a result of the destructive weapons. A composite student set up as a result of the responses to Part II would be as follows: he thinks often about the possible effects of the atomic bomb and biological weapons on himself and his future life, but has not materially altered any plans for his future as a result of the weapons, although he has hesitated slightly in certain plans; he chose science without atomic development being a significant factor, and at the present time plans to do research, with the possibility of teaching or industry after that if research does not remain the permanent phase of his career in science.

In the group studied, the positive attitude has had as its concomitant a clear indication of strong faith and confidence in the future in spite of atomic and biological weapons. Concerning the function of science education in regard to the shaping of attitudes which are partially derived and formulated through classroom activity, there are several points to be considered: first, science education must coordinate its activities with religion, society, and government in resisting the frequently negative effects of the atomic bomb and biological warfare on attitudes; secondly, the individual science instructor must be informed of the social implications of the atomic bomb and biological warfare, and recognize their importance; thirdly, the science instructor should stimulate discussion of these implications to make the student keenly aware of all the known factors and thus stimulative reflective thinking; and finally, the science instructor should logically integrate the discussion with existing social values. Each of these steps is an incentive to the advanced science student to formulate his own hypotheses, conclusions, and finally derive the attitude through reflective thought.

The conclusions based on this study have indicated a positive attitude by the group toward the continuation of our civilization and accompanying confidence in their future. This attitude is imperative in the atomic age, because without it

there is no reason to plan for future activity, and thus rendering life worthless. With a strong positive attitude indicating faith in man's reason and common sense to end destruction and wars before they destroy him completely, man can continue on in the ways of education, peace, and a spirit of goodwill; fulfillment of this means the continuance and furtherance of our civilization.

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APPENDIX

A SURVEY OF ATTITUDES

This is not a test. There will not be any marks, and there is no right or wrong. Merely check your honest opinion based on the following facts about the atomic bomb and biological warfare (which you may accept as true), and on any other information you may have about these destructive scientific achievements. When you check your answers, keep in mind the facts by referring back to them.

Statement of Facts: Atomic energy has many peacetime possibilities which can help mankind considerably, but you must be aware of and respect its destructive qualities. The atomic bomb can kill you in at least four ways: if the bomb were set off within a few miles of you, you could be destroyed by the initial blast, by the 1000-mile-per-hour winds which result, by the tremendous scorching heat, or by the radioactivity which occurs at the time of the explosion. Breaking up homes and communities and dispersing underground would be the fate of the survivors, who might never again see the sun and breathe fresh air. Even so, people in bombproof shelters under six feet of concrete can be killed by certain rays from the synthetic radioactives sprinkled on the ground above.

As for biological (germ) warfare, the U. S. Army Chemical Warfare Service has an innocent-looking crystalline toxin (botulinus) so poisonous, that if an ounce were thoroughly dispersed, it would kill everybody in the United States and Canada. However, this botulinus toxin must be swallowed to have its deadly effect. Then there is the psittacosis (parrot fever) virus, one milliliter of which could kill twenty million individuals. Other countries are reported to be developing similar and deadly poison germs.

Part I - In each of the following, you are given a statement which can be completed in any one of five ways. Check whichever of the five most closely follows your own opinion.

1. The atomic bomb will wipe out all traces of our civilization within a few years.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

2. Scientists will control the destiny of the world because of their ability to create destructive weapons.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

3. There is little an individual can do about what is going to happen to this world, even if he organizes into strong groups which can voice opinions.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

4. Writing to the congressmen who help to shape our foreign policy is worthwhile.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True.. .Probably True....

5. The existence of the atomic bomb and the possibility of germ warfare means that the present time is the last chance for one united world.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

6. The United Nations has a good chance of succeeding if, instead of conflicts, points of agreement among nations are emphasized.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

7. The United Nations will never work unless it has a strong military force which will use the atomic bomb, if necessary, to keep every country in line.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

8. Since most of our present social environment is bad, some good may come of the atomic bomb if it wipes out most of the society, and forces us to start anew.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

9. It is not the social environment, but the people living in it who determine the patterns in which events will take place.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

10. The United States is the only country that can be trusted with the atomic bomb and to share the secrets of its manufacture may be disastrous to us.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

11. If called on to fight for this country in another war, you would volunteer if you felt that you really understood and believed in the reason why another war might be necessary.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

12. Fate determines a large share of everything that takes place, so we may as well resign ourselves to probable destruction.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

13. Common sense and reason will prevail, and the atomic bomb and germ warfare will never be utilized for destructive purposes.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

14. Science and scientists should be condemned for creating the atomic bomb and biological warfare.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

15. Wars and destruction among men are unavoidable and should be accepted as part of our civilization.

In your opinion, this statement is:

Probably False....Possibly False....No Opinion....Possibly True....Probably True....

Part II - Check the word or statement which best fits your situation.

1. Have you ever thought about the possible effects of the atomic bomb and biological warfare on you and your future life?

   never.....sometimes.....often.....constantly....

2. The rapid progress in atomic development was a factor in your choosing science as your life's work,

   a. because it opened vast new fields of research.....
   b. because it demonstrated the control of science over our lives.....
   c. because it seemed a thrilling type of work with which to be associated.....
   d. because it first called your attention to the importance of science.....
   e. not at all.....

3. Has the invention of the atomic bomb and the possibility of its use made you hesitate to make any of the following plans for your future?

   a. marriage.....
   b. children.....
   c. banking money.....
   d. further schooling.....
   e. owning your own home.....
   f. others (specify)......

4. Has the invention of the atomic bomb and the possibility of its use made you decide to make any of the following plans for your future?

   a. changing residence to another section of this country.....
   b. living abroad.....
   c. enlisting in the armed forces.....
   d. remaining single.....
   e. if married, not to have children.....
   f. others (specify).....

5. Which of the following represents your present plans for your future in science?

   a. Remain in the same field in science and enter:
      Teaching.....
      Research.....
      Graduate Study.....
      Foreign Study.....
      Application of your field in science to other types of work......
   b. Change to another field in Science.....
   c. Change to a field other than science.....
   d. Leave School.....
   e. Others (Specify).....

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